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A Systematic Qualitative Review of Teachers' Strategies in Enhancing Mathematical Reasoning in Elementary Schools

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Abstract
Mathematical reasoning skills are a fundamental aspect in mathematics learning that contributes to students' conceptual understanding and problem-solving. This study aims to identify and analyze the strategies applied by teachers in improving students' mathematical reasoning skills in elementary schools. The research method used is a qualitative review based on literature studies and data analysis from relevant previous research. The results showed that teachers applied various strategies, including problem-based learning (PBL), group discussions, scaffolding, and the use of technology and interactive media in the learning process. In addition, metacognitive and reflective approaches have proven to be effective in improving students' critical and analytical thinking skills. These findings provide insight for educators in developing more effective teaching methods to improve students' mathematical reasoning.

Keywords: *Problem Teaching Strategies; Mathematical Reasoning; Metacognitive Approach*

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Introduction

Mathematical reasoning is a fundamental aspect of learning mathematics from an early age, because it plays a role in building deep conceptual understanding and logical thinking skills in children (Lee et al., 2018). This ability allows students to connect mathematical concepts, identify patterns, and develop systematic problem-solving strategies (Zonnefeld & Helming, 2024; Wei et al., 2022). According to some studies, children who have good mathematical reasoning tend to be better able to cope with academic challenges at higher levels of education. In addition, mathematical reasoning also contributes to overall cognitive development, as it trains children in critical thinking, making generalizations, and developing logic-based argumentation (Smit et al., 2019). Therefore, the strengthening of mathematical reasoning from an early age is a crucial element in basic education, which not only has an impact on academic achievement in mathematics, but also in various other aspects of life (Yayuk et al., 2020).

In the context of learning in elementary schools, the application of teaching strategies that encourage the development of mathematical reasoning is very important (Nurtamam et al., 2023). Teachers need to design learning activities that not only focus on arithmetic calculations, but also invite students to explore mathematical concepts in more depth through discussions, problem-solving, and real-world context-based experiments (Zulkifli et al., 2022;

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Shone et al., 2023). Inquiry-based learning approaches, problem-based learning, and the use of manipulative media have proven to be effective in improving children's mathematical reasoning skills. By giving students the opportunity to think reflectively and practice in a variety of problematic situations, they will be better prepared to face more complex mathematical challenges in the future (Sevinc & Galindo, 2022; Setiyani et al., 2022). Therefore, the integration of strategies that encourage logical and analytical thinking from an early age is an important investment for students' intellectual development in the long term.

Mathematical reasoning plays an important role in building the conceptual understanding of elementary school students (Sari et al., 2023), as it allows them to see the relationships between various mathematical concepts in more depth. This ability helps students not only in memorizing procedures or formulas, but also in understanding the reasoning behind each step of problem-solving (Ali et al., 202.; Putranta et al., 2021; Syafruddin et al., 2024). With a strong understanding, students can transfer their knowledge to new situations and apply mathematical concepts in everyday life(Sevinc & Galindo, 2022). In addition, mathematical reasoning contributes to shaping an analytical mindset that allows students to identify patterns, make predictions, as well as develop more effective problem-solving strategies(Kramarski, 2008). In the long run, students with good mathematical reasoning skills will be better prepared to face academic and workplace challenges that require critical thinking skills and adaptation to complex situations (Lee et al., 2018;Ichsan et al., 2023; Zulyusri et al., 2023)

In addition to building conceptual understanding, mathematical reasoning also plays a role in developing the logical thinking skills of elementary school students(Manmai et al., 2021). Through activities such as pattern exploration, deduction, and generalization, students learn how to draw conclusions based on existing evidence and systematically test the validity of a statement. This process not only strengthens their ability to solve mathematical problems, but also improves logical thinking skills that can be applied in a variety of other fields, such as science and day-to-day decision-making (Jensen & Skott, 2022). Therefore, it is important for educators to adopt learning methods that stimulate mathematical reasoning, such as problem-based learning, group discussions, and inquiry-based approaches. Thus, students not only understand mathematical concepts in more depth, but also develop a more analytical and rational mindset, which will be beneficial in their academic development and future lives (Yayuk et al., 2020; Kramarski, 2008).

Teachers at the elementary school level face various challenges in developing students' mathematical reasoning, one of which is the limitation of students' conceptual understanding of mathematics (Trisnawati et al., 2024). Many students tend to memorize procedures without understanding the underlying basic concepts, so they have difficulty applying that knowledge to new situations (Cai, 2000). The dense curriculum also often requires teachers to complete the material in a limited time, so learning tends to focus on solving problems mechanically rather than strengthening conceptual understanding and mathematical reasoning. In addition, the diversity of students' abilities in a class is a challenge in itself, where some students are able to understand concepts quickly, while others require a more intensive approach. This makes teachers have to adjust teaching strategies in order to meet the needs of all students effectively (Pateda et al., 2025; Syafruddin et al., 2024).

Another challenge comes from the limited resources and learning methods that support the development of mathematical reasoning. Many schools still lack teaching aids, interactive learning media, and training for teachers in applying more innovative methods, such as problem-based learning or inquiry-based approaches (Erdem & Soylu, 2020). In addition, students' and parents' perceptions of mathematics as a difficult subject often hinder learning motivation, so teachers must find ways to increase students' interest in exploring mathematical concepts in more depth (Guner & Akyuz, 2020). The lack of support in the form of professional development for teachers is also an obstacle, where many teachers still rely on conventional methods without exploring more effective strategies in building students'

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mathematical reasoning (Alsina et al., 2025). Therefore, collaborative efforts from various parties, including schools, governments, and the community, are needed to improve the quality of mathematics learning and ensure that students can develop logical and analytical thinking skills optimally.

The development of mathematical reasoning from an early age requires innovative and effective teaching strategies so that students can understand mathematical concepts more deeply(Zonnefeld & Helming, 2024b). Mechanistic learning methods, such as repetitive questioning without concept exploration, have been proven to be less effective in building critical and analytical thinking skills in students. Therefore, an approach is needed that encourages students to actively think, explore patterns, and develop problem-solving strategies. Some innovative strategies that can be applied include Problem-Based Learning, inquiry approaches, and the use of teaching aids and interactive technology(Slavin & Lake, 2008). These strategies not only help students understand concepts in more depth, but also increase their engagement in the learning process. By engaging students in challenging, contextual-based activities, they can develop logical thinking skills as well as the ability to generalize concepts in a variety of real-life situations (Mastuti et al., 2022).

Research conducted by Carpenter et al. (1999) shows that a problem-solving-based approach and class discussion can help students understand mathematical concepts more deeply. This study emphasizes that teachers who provide opportunities for students to explore various problem-solving strategies are able to improve students' logical and analytical thinking skills. In addition, research conducted by NCTM (*National Council of Teachers of Mathematics)* emphasizes the importance of using inquiry-based approaches and visual representations in developing students' mathematical understanding. Qualitative research by Kazemi and Stipek (2001) highlights that a classroom environment that supports mathematical discussion can improve students' reasoning skills. Teachers who adopt an open-ended question strategy and encourage students to explain their thought processes are able to create a stronger culture of critical thinking in math learning. Another study by Boaler (2016) emphasizes that a growth mindset-based approach in teaching mathematics can encourage students to be more confident in facing mathematical challenges, thereby improving their ability to reason and solve problems.

Although various studies have discussed teaching strategies to improve elementary school students' mathematical reasoning, most studies still focus on quantitative approaches and analysis of the effectiveness of specific methods separately. The lack of studies that explore in depth how teachers apply different strategies in different contexts and the challenges they face is a research gap that needs to be filled. In addition, most studies have not fully explored teachers' perspectives in adapting their strategies to the diverse needs of students (Sevinc & Galindo, 2022). Therefore, this study offers novelty with a qualitative approach that comprehensively examines the strategies used by teachers in improving students' mathematical reasoning, including implementation challenges and applied solutions. Thus, the results of this research are expected to provide deeper insights into effective teaching practices and become the basis for the development of more adaptive and innovative education policies. Therefore, this study aims to identify and analyze the strategies applied by teachers in improving students' mathematical reasoning skills in elementary school.

Methodology

This study uses a qualitative approach with the literature review method to analyze various strategies applied by teachers in improving the mathematical reasoning of elementary school students. This approach aims to identify effective teaching patterns based on previous research as well as explore the challenges faced in its implementation. Data is collected through a systematic review of scientific journals, academic books, and research reports relevant to the topic. The sources analyzed were selected based on their credibility, such as publications from Scopus indexed journals or Web of Science, as well as research conducted

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in the context of basic education. Data analysis was carried out using the thematic analysis method, namely by identifying the main themes related to teaching strategies, their effectiveness, and the obstacles experienced by teachers in improving students' mathematical reasoning.

In the analysis process, this study follows systematic stages, including searching for literature with appropriate keywords, filtering relevant sources, and synthesizing findings to obtain a comprehensive overview of best practices in mathematics learning. The validity of the research is maintained through data triangulation by comparing various different sources to ensure consistency of results. In addition, this study also pays attention to the limitations in the study studied to provide a critical perspective on the results obtained. With this approach, research is expected to contribute to understanding how teachers implement innovative learning strategies to improve the mathematical reasoning of primary school students, as well as offer evidence-based recommendations for curriculum development and education policies.

Result and Discussion

Effective Teaching Strategies in Improving Mathematical Reasoning in Primary School Students

Mathematical reasoning is a fundamental cognitive skill that enables students to analyze problems, identify patterns, and construct logical arguments. In primary education, fostering strong mathematical reasoning is crucial as it lays the foundation for advanced problem-solving skills in higher education and real-world applications(Sibgatullin et al., 2022). However, traditional rote-learning methods often fail to develop students' critical thinking and reasoning abilities effectively. Therefore, implementing innovative and evidence-based teaching strategies is essential to enhance students' mathematical reasoning. Several strategies, including inquiry-based learning, problem-based learning, visual representation, collaborative learning, and technology-assisted instruction, have been shown to significantly improve students' mathematical reasoning abilities (Sinwell, 2024).

One of the most effective approaches in strengthening mathematical reasoning is inquiry-based learning (IBL) (Sari et al., 2023). This strategy encourages students to explore mathematical concepts through guided inquiry, questioning, and problem-solving activities. Instead of passively receiving information, students actively engage in discovering mathematical relationships, which enhances their conceptual understanding and logical thinking (Santosa et al., 2022; Zulyusri et al., 2023). Research has shown that IBL fosters deeper cognitive engagement by allowing students to develop hypotheses, test their ideas, and refine their reasoning based on evidence. Teachers play a crucial role in facilitating inquiry-based lessons by posing thought-provoking questions and guiding students through reflective discussions (Setiyani et al., 2022). Another impactful approach is problem-based learning (PBL), where students tackle real-world mathematical problems that require logical reasoning and analytical thinking. This method shifts the focus from memorization to active problem-solving, promoting a deeper understanding of mathematical principles. PBL encourages students to apply their knowledge to novel situations, thereby improving their ability to think critically and make connections between different mathematical concepts (Wei et al., 2022). Studies have shown that students who engage in PBL demonstrate greater mathematical reasoning skills than those taught through conventional methods, as they develop the ability to approach problems systematically and justify their solutions with logical arguments.

The use of visual representations and manipulatives is also a key strategy in developing mathematical reasoning in young learners (Sari et al., 2023). Visual tools such as diagrams, number lines, and geometric models help students grasp abstract mathematical concepts by providing concrete representations. Manipulatives, such as blocks, fraction strips, and algebra tiles, offer hands-on experiences that enable students to experiment with mathematical ideas (Erdem & Soylu, 2020). Research suggests that incorporating visual and

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physical representations in teaching mathematics enhances students' ability to generalize patterns, recognize relationships, and construct logical arguments. Teachers should integrate these tools effectively to scaffold students' understanding and gradually transition them toward abstract reasoning (Wei et al., 2022).

Furthermore, collaborative learning and mathematical discourse play a vital role in improving students' reasoning skills. When students work together in small groups to solve mathematical problems, they engage in discussions that require them to explain their thought processes, critique each other's reasoning, and justify their answers. This collaborative approach not only strengthens their mathematical communication skills but also deepens their understanding through peer interaction. Studies have highlighted that students who frequently participate in mathematical discussions develop stronger reasoning abilities, as they learn to construct and evaluate arguments critically (Syafruddin et al., 2024). Teachers should foster a classroom environment that encourages open dialogue, questioning, and peer feedback to cultivate mathematical reasoning skills. technology-assisted learning has emerged as an effective tool for enhancing mathematical reasoning in primary school students. Digital platforms, interactive simulations, and educational apps provide students with engaging and adaptive learning experiences (Sibgatullin et al., 2022). Technology allows for personalized instruction, immediate feedback, and interactive problem-solving, which supports students in developing logical thinking and reasoning. Research indicates that the integration of technology in mathematics education can improve students' ability to analyze data, visualize mathematical relationships, and develop strategic problem-solving skills. However, teachers must carefully select technological tools that align with pedagogical goals and ensure meaningful integration into the curriculum (Jablonski, 2023)

By incorporating these effective teaching strategies—inquiry-based learning, problem-based learning, visual representations, collaborative learning, and technology-assisted instruction—educators can significantly enhance students' mathematical reasoning. These methods not only develop students' cognitive abilities but also foster a deeper appreciation for mathematics as a subject of logical exploration and discovery(Mukuka et al., 2023). Moving forward, continuous research and professional development programs for teachers are essential to ensure the successful implementation of these strategies in primary education settings.

Interactive Learning Technology and Media for Elementary School Students

The integration of interactive learning technology and media in elementary education has revolutionized traditional teaching methods by enhancing student engagement, motivation, and comprehension. As digital tools become increasingly accessible, educators are leveraging interactive technologies to create dynamic learning experiences that cater to diverse learning styles (Shone et al., 2023). Interactive learning technology, such as educational applications, gamified learning platforms, augmented reality (AR), virtual reality (VR), and multimedia content, provides students with opportunities to explore concepts in a more engaging and hands-on manner (Kramarski, 2008). These tools not only facilitate deeper understanding but also encourage active participation, critical thinking, and collaboration among students.

One of the most effective forms of interactive learning technology is gamification in education, where game-based elements such as rewards, challenges, and progress tracking are integrated into learning activities. Gamified learning platforms, such as Kahoot, Prodigy, and Duolingo, provide an engaging and competitive environment that motivates students to actively participate in lessons (Hart et al., 2011; Putra et al., 2023). Research has shown that gamification enhances student engagement and retention by making learning enjoyable and interactive. Through real-time feedback and adaptive learning paths, students can progress at their own pace while developing problem-solving and decision-making skills (Yayuk et al., 2020).

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Another impactful technological advancement is augmented reality (AR) and virtual reality (VR) in education. AR and VR technologies offer immersive learning experiences that allow students to visualize abstract concepts and interact with virtual environments. For instance, AR applications can bring historical events to life, enable 3D explorations of the human body, or provide interactive geometry lessons. Similarly, VR-based learning can simulate real-world experiences, such as virtual science labs or historical site visits, enhancing students' understanding of complex subjects. Studies indicate that AR and VR significantly improve knowledge retention and conceptual understanding by providing experiential learning opportunities (Herbert et al., 2015). Multimedia learning materials, including interactive videos, animations, and digital storytelling, also play a crucial role in elementary education. Unlike static textbooks, multimedia content combines visual, auditory, and kinesthetic elements, making learning more accessible and engaging for young learners. Interactive videos that incorporate quizzes, branching scenarios, and embedded explanations enable students to actively engage with the content rather than passively consuming information. Research supports the use of multimedia in education, as it caters to different learning styles and enhances cognitive processing, ultimately leading to better comprehension and long-term retention.

Furthermore, collaborative digital tools and online learning platforms facilitate communication, cooperation, and knowledge-sharing among students. Platforms such as Google Classroom, Microsoft Teams, and Padlet enable students to work on projects collaboratively, exchange ideas, and receive feedback from teachers and peers (Rakić et al., 2020). These tools foster 21st-century skills, including digital literacy, teamwork, and critical thinking, which are essential for future academic and professional success (Lee et al., 2018). Additionally, real-time collaboration allows for a more inclusive learning environment, where students can engage in discussions, share resources, and co-create content, regardless of their geographical location.

Despite the numerous benefits of interactive learning technology, its successful implementation requires effective pedagogical integration and teacher readiness. Educators must receive proper training to utilize digital tools efficiently and align them with learning objectives (Kenedi et al., 2019). Moreover, accessibility and infrastructure challenges, such as the digital divide, must be addressed to ensure equitable access to technology for all students. As research continues to explore the impact of interactive learning technologies, future developments should focus on adaptive learning systems, artificial intelligence-driven personalization, and ethical considerations in digital education (Sansome, 2025). By strategically integrating interactive learning technologies and media, elementary education can be transformed into a more engaging, inclusive, and effective learning experience.

Policies to Improve Access To Educational Resources and Technologies That Support Mathematical Learning

Ensuring equitable access to educational resources and technologies is a crucial policy goal in improving mathematical learning outcomes (Waladi et al., 2023). As technology-driven learning environments become more prevalent, disparities in access to digital tools can exacerbate educational inequalities. Policies aimed at bridging the digital divide must focus on providing sufficient infrastructure, affordable internet connectivity, and access to quality digital learning materials (Smit et al., 2019). Governments and educational institutions must collaborate to develop frameworks that ensure all students, regardless of socioeconomic background, have equal opportunities to benefit from technology-enhanced mathematical learning (Guner & Akyuz, 2020).

One fundamental policy approach is expanding funding for digital infrastructure in schools, particularly in underserved communities. Governments should allocate budgets for equipping classrooms with computers, tablets, and interactive whiteboards that facilitate digital mathematical learning. Additionally, investment in stable internet connectivity is

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essential, as many online learning platforms and digital resources require reliable access to function effectively (Setiyani et al., 2022). Providing schools with adequate technological resources ensures that students can engage with interactive learning tools such as educational apps, virtual simulations, and online assessments.

Another critical aspect of policy development is teacher training and professional development programs in integrating technology into mathematics instruction. Merely providing access to digital tools is insufficient if educators lack the skills to effectively incorporate them into their teaching strategies (Kenedi et al., 2019). Policies should mandate ongoing professional development to equip teachers with the necessary skills to utilize educational technologies, such as dynamic geometry software, AI-based tutoring systems, and gamified learning platforms. This training should emphasize evidence-based teaching methods that leverage technology to enhance mathematical reasoning and problem-solving skills (Fraihat et al., 2022).

To improve accessibility, policies should also focus on developing and curating high-quality open educational resources (OERs) for mathematics learning. OERs, such as free digital textbooks, instructional videos, and interactive simulations, allow students and teachers to access high-quality learning materials at no cost (Erdem & Soylu, 2020). Governments and academic institutions should collaborate to create comprehensive digital libraries that offer standardized and adaptable content aligned with curriculum requirements. Ensuring that these resources are available in multiple languages and formats can further enhance accessibility for diverse student populations.

Additionally, public-private partnerships (PPPs) can play a pivotal role in expanding access to educational technologies. Collaborations between governments, technology companies, and non-profit organizations can facilitate the distribution of low-cost devices, subsidized internet plans, and free access to premium educational software (Trisnawati et al., 2024; Oktarina et al., 2021; Zulyusri et al., 2023). Policymakers should create regulatory frameworks that incentivize technology companies to invest in educational initiatives, ensuring that the benefits of digital learning reach a broader audience. Successful PPP models have demonstrated positive impacts in various regions by providing students with access to digital resources that enhance their mathematical proficiency.

Finally, monitoring and evaluation mechanisms should be embedded within educational policies to assess the effectiveness of technology-driven learning initiatives. Policymakers must implement data-driven approaches to track student progress, identify gaps in access, and refine strategies accordingly (Erdem & Soylu, 2020; Santosa et al., 2022; Utomo et al., 2023, 2023). Regular assessments, feedback loops, and research studies can help determine the impact of digital learning tools on mathematical achievement. By continuously refining policies based on empirical evidence, governments can ensure that technological interventions in education lead to meaningful improvements in student learning outcomes (Ahmad et al., 2021).

Conclusion

From the results of this study, it can be concluded that teachers apply various strategies, including problem-based learning (PBL), group discussions, scaffolding, and the use of technology and interactive media in the learning process. In addition, metacognitive and reflective approaches have proven to be effective in improving students' critical and analytical thinking skills. These findings provide insight for educators in developing more effective teaching methods to improve students' mathematical reasoning. The implications of this study emphasize the importance of implementing diverse and innovation-based teaching strategies in improving the mathematical reasoning of elementary school students. Teachers need to optimize approaches such as problem-based learning (PBL), group discussions, scaffolding, and the use of technology and interactive media to create a more dynamic learning environment and support the development of students' analytical thinking. In addition, these

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findings underscore the need to strengthen teacher training so that they can implement more effective and evidence-based learning strategies. For policymakers, the results of this study are the basis for designing educational policies that support improving the quality of mathematics learning, including in the provision of equitable technological resources. Thus, this research contributes to the improvement of the overall mathematics learning system and supports the improvement of students' numeracy competencies from an early age.

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